



PANGAEA

STIMULATION & TESTING

EP167

ENVIRONMENTAL MANAGEMENT PLAN

SUMMARY

**STIMULATION AND TESTING
ENVIRONMENTAL MANAGEMENT PLAN SUMMARY**

TABLE OF CONTENTS

1. INTRODUCTION	3
2. DESCRIPTION OF ACTIVITY	4
3. DESCRIPTION OF THE ENVIRONMENT.....	4
4. DESCRIPTION OF THE ACTIVITY IN RELATION TO THE ENVIRONMENT	5
5. ENVIRONMENTAL RISKS OF PROPOSED ACTIVITY AND CONTROL MEASURES	5
6. CONSULTATION	7
7. PANGAEA LIAISON PERSONNEL.....	7

STIMULATION AND TESTING ENVIRONMENTAL MANAGEMENT PLAN SUMMARY

1. INTRODUCTION

EP167 is located approximately 400 km southeast of Darwin in the Northern Territory (NT) in the Roper Basin. The tenement falls within the Victoria-Daly, Roper-Gulf and Barkly Shires plus the Katherine Municipality. All activities described in this EMP Summary are in the Roper-Gulf Shire.

Pangaea intends to return to two Appraisal Wells that were completed in July and August 2015 (Birdum Creek-1 and Wyworrie-1 Appraisal Wells) to undertake stimulation and testing operations. The program will utilise tracks on pastoral land for which Pangaea currently have voluntary pastoral access agreements in place. A location map and coordinates of the activity are provided in Figure 1.

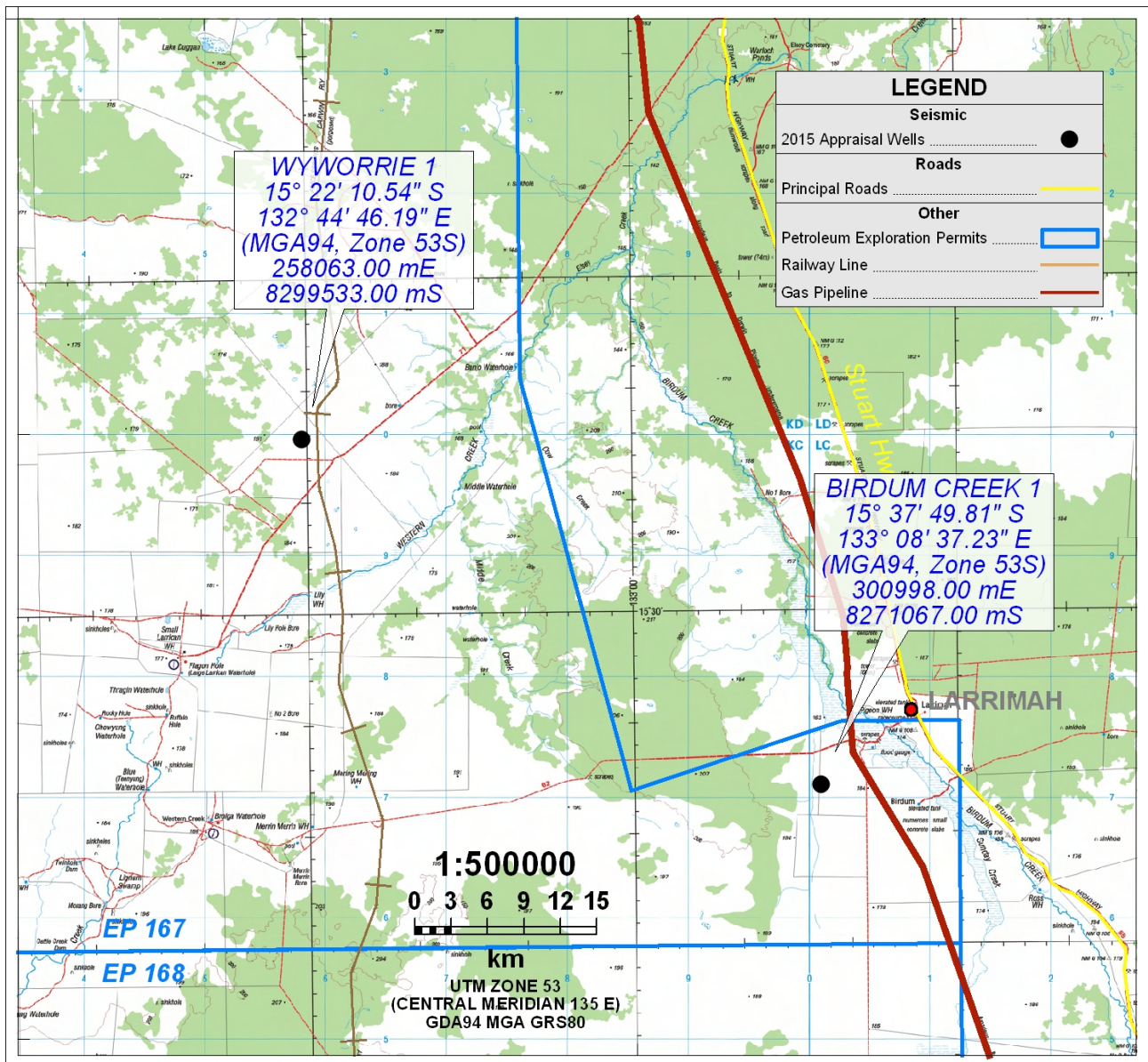


Figure 1: Location of the Appraisal Well sites for Stimulation & Testing Operations

STIMULATION AND TESTING
ENVIRONMENTAL MANAGEMENT PLAN SUMMARY

2. DESCRIPTION OF ACTIVITY

Birdum Creek-1 and Wyworrie-1 Appraisal Wells were drilled and suspended in July and August 2015 respectively as part of Pangaea's 2015 Appraisal Campaign, in order to gather further information on stratigraphic and rock properties in EP167. Both Appraisal Wells will undergo stimulation and testing.

The Appraisal Wells have been designed and constructed to accommodate the stimulation process without risk to well integrity. In preparation for the Stimulation & Testing operations, well integrity tests including cement evaluation have been completed on both Appraisal Wells.

The operation will involve the following stages:

- Well preparation including Wireline Logging;
- Pressure testing of the well casing and surface equipment to further ensure wellbore integrity and surface safety;
- Perforation and pumping;
- Testing; and
- Well Suspension – (cement plugged back).

The program has been designed in consultation with local pastoralists and traditional owners to avoid areas of environmental, cultural or archaeological significance.

3. DESCRIPTION OF THE ENVIRONMENT

The region's climate is *'semi-arid tropical, with rainfall concentrated in the wet season months between November and April. Though rainfall can be variable from year to year, there is a distinct gradient of decreasing mean annual falls from 850mm in the north to less than 500mm'* in southern areas of EP167, with nearly all the rainfall occurring between November and April (see Williams *et al.* 1997¹, Hennessy *et al.* 2004²). The mean maximum temperature varies from 27°C in July to 40°C and above in November.

Condition is generally good across much of the bioregion. In EP167, the Appraisal Well locations both intersect with the Forrest land system. The Forrest land system consists of gently sloping sandy surfaced plains with few indistinct drainage depressions on sandy red earth soils. Vegetation is dominated by eucalypt woodlands and perennial grasses, the systems are generally suitable for pasture improvement and have moderate to high grazing potential. The Forrest land system consists of vegetation that have a relatively low forage quality in the dry season but it can benefit from strategic burning to manage woody thickening (Northern Territory Government, no date³).

¹ Williams, R.J., Cook, G.D., Ludwig, J.L. and Tongway, D.L. (1997). Torch, trees, teeth and tussocks: disturbance in the tropical savannas of the Northern Territory (Australia). In: *Frontiers in Ecology. Building the Links*. Eds. N. Klomp and I. Lunt. Elsevier, Oxford: pp55-66.

² Hennessy, K., Page, C., McInnes, K., Walsh, K., Pittock, B., Bathols, J. and Suppiah, R. (2004). *Climate Change in the Northern Territory*. Consultancy report for the Northern Territory Department of Infrastructure, Planning and Environment. CSIRO, Melbourne.

³ Northern Territory Government (no date) *Land Condition Guide - Sturt Plateau District; Understanding the productivity of grazing lands*. Produced in association with the Northern Territory Cattlemen's Association as part of the Caring for Our Country project "Grazing Land Management – Demonstration, Continuation and Evaluation".

STIMULATION AND TESTING
ENVIRONMENTAL MANAGEMENT PLAN SUMMARY

4. DESCRIPTION OF THE ACTIVITY IN RELATION TO THE ENVIRONMENT

The Stimulation and Testing Program has been designed with due consideration of the surface and subsurface environments. To minimise impacts on the environment, existing roads, tracks, fire-breaks and fence lines have been used to access both Appraisal Well locations wherever possible. The operations will utilise one already existing centrally located camp site.

As described previously, both Appraisal Wells have been designed and constructed to accommodate the stimulation process without risk to well integrity.

The first stage of the program involves re-entering the Appraisal Well and undertaking wireline logging operations.

Following this, one (1) fracture stimulation treatment (one stage) will be performed on each Appraisal Well within the target zone. This treatment will consist of perforating the target zone and pumping a mixture of water with conditioning agents and sand (proppant) into the well at a high pressure in order to create and support small fissures through which gas can move into the wellbore.

Most of the conditioning agents used are found among household products or in industry. All fracture fluids and conditioning agents are approved and used in accordance with guidelines set down by the NT EPA, NT Department of Mines and Energy and other regulatory agencies. All fracture fluids and conditioning agents are managed with care to avoid any potential for impact on human health or the environment.

Following the single fracture treatments on both Appraisal Wells, the wells will be opened and 'flowback' consisting of diluted stimulation fluid and sand (from the stimulation operations) will occur. Flowback volumes vary depending on rock mechanics and parameters of the stimulated zone. Based on experience over decades from similar shale testing in the United States, it is expected that approximately 35-50% of the total injected fluid will be recovered.

Following initial flowback, the well will be production tested for up to 10 days for the purpose of observing and measuring flow rates and pressures of natural gas. All operations will be continually monitored and recorded.

The handling and storage of flowback fluids will comply with Clause 112(3) of the Schedule of Onshore Petroleum Exploration and Production Requirements 2012. Recovered fluid in the lined ponds will be pumped out into an NT EPA approved and licenced vehicle before being taken to the nearest NT EPA approved facility.

5. ENVIRONMENTAL RISKS OF PROPOSED ACTIVITY AND CONTROL MEASURES

Fauna and flora

The stimulation and testing program has been designed to ensure minimum impact on local flora and fauna. The stimulation and testing program will potentially be a minor temporary barrier to movement of fauna, however the small scale of the operational footprint (a 100m x 100m drill pad at either location) is unlikely to affect the migration or dispersal ability of fauna. Weed and pest inspections on all vehicles & personnel clothing will be undertaken prior to arrival at the sites and both will be appropriately fenced to minimise any risk to terrestrial species during operations.

Noise and surface

Speed limits will be enforced on access tracks to limit and minimise dust and noise generation. Vehicular movements to and from the work sites will be minimised by travel during daylight hours only and be compliant with land access agreements. Soil erosion will be minimised by the use of existing tracks, deviating around creeks, river banks and naturally formed depressions and not accessing unsealed roads in wet conditions.

STIMULATION AND TESTING
ENVIRONMENTAL MANAGEMENT PLAN SUMMARY

Waste and chemical management

Waste will be stored in suitable receptacles and disposed of accordingly at municipal managed locations. Waste materials shall be transported, stored and handled in accordance with the requirements of the relevant legislation and guidelines. Chemicals will be stored and handled in accordance with relevant standards and guidelines and contained within the contractor's equipment.

Pangaea will implement the following strategies:

- Ensure that material handling and safety aspects of conditioning agents are in accordance with relevant Material Safety Data Sheets, relevant standards and guidelines including AS 1940;
- Regular audit of the primary contractor's management systems and operations to ensure compliance with the approved Environmental Management Plan (EMP) for the operations;
- On-site supervision to monitor conduct of operations and ensure any incidents are recorded and dealt with in accordance with the approved EMP;
- Using water, sand and conditioning agents to perform the stimulation operation;
- Containment of recovered flow back fluids in lined ponds;
- Monitoring and sampling of flow back fluids before treatment and/or disposal offsite at a NT EPA approved location;
- Management of flow back containment ponds to ensure their integrity;
- Removal of pond liner and disposal at an NT EPA approved waste facility; and
- Rehabilitation of containment pond sites post activities.

Groundwater

Potable and non-potable aquifers are isolated by several layers of steel casing and cement installed during the drilling process. The well design ensures the structural integrity within the wellbore to isolate the aquifers during stimulation, flowback operations and throughout the life of the well. Prior to the stimulation and testing operations described, well integrity tests have been successfully undertaken at both sites to ensure they maintain their integrity throughout the stimulation operation. Flowback stimulation fluid will be stored in lined and fenced off temporary containment ponds that are to be constructed to ensure no leakage to the environment. The containment ponds will be regularly inspected, bunded with a 1.5m earth wall and approved with an additional 30% over-capacity to avoid the risk of over-flow in the event of heavy rain events.

Pangaea commissioned an independent environmental baseline study to provide a robust record of significant water components such as hydrology, standing water levels and chemical compositions as they existed prior to drilling and stimulation testing. This study covers a large region and provides information both at the regional level and near the areas undergoing stimulation tests. The same methodology will be followed post-stimulation to document any unexpected change, or lack of change, in water conditions from the time of stimulation and testing. Pangaea will continue to assess, extend and analyse these studies throughout the course of its appraisal campaign.

STIMULATION AND TESTING
ENVIRONMENTAL MANAGEMENT PLAN SUMMARY

6. CONSULTATION

During 2015, Pangaea has consulted with numerous stakeholders. Key consultation outcomes include:

- A detailed cultural heritage assessment and sacred site clearance process was agreed and completed with the Northern Land Council and Traditional Owners;
- The negotiation and signing of voluntary access agreements with directly-affected Pastoralists;
- Public availability to and direct engagement with communities and representative groups at exhibition booths during district and agricultural shows e.g. Katherine and Tennant Creek District Shows (2014, 2015);
- Notification to local government councils, police authorities and local businesses of exploration activities; and
- Compliance with legislation and guidelines from the NT Department of Mines and Energy and other regulatory agencies e.g. Department of Transport, NT EPA and Department of Infrastructure.

Pangaea's engagement process is aimed to identify and address issues of concern, reach agreement and in general engage in goodwill communication.

Pangaea will continue this process with stakeholders throughout the life of the project.

7. PANGAEA LIAISON PERSONNEL

Sydney Office		
Executive Director	Tim Radburn	Phone: (02) 9017 9600